

[0001] Field of the Invention

[0002] The invention relates to a rotary leadthrough of a robot arm, in particular of a fourth axle of a Delta robot, as generically defined by the preamble to claim 1.

[0003] Prior Art

[0004] Delta robots are known from European Patent Disclosures EP-B 0 250 470, EP-A 1 129 829, and EP-A 1 293 691. These Delta robots are suitable for moving objects precisely and in a guided way in three-dimensional space. They have proven themselves in practice and are used, among other fields, in the food industry or in machining centers that have stringent cleanliness requirements. Cleaning the rotary leadthrough of the fourth axle, however, is sometimes complicated. Until now, this rotary leadthrough has been embodied such that a hollow shaft was supported in a housing, and the shaft had a radial inflation opening in its central void.

[0005] Precisely in the aforementioned areas of use, however, it would be desirable to be able to clean the entire robot and especially the region of the rotary leadthrough of the fourth axle better and more simply.

[0006] US Patent 5,775,169 moreover discloses a robot arm that is used for manipulation in a vacuum chamber, but that is operated from outside. The robot arm is

rotatably supported in a housing, and there is a seal in the housing, for dividing the part of the robot arm toward the vacuum from the part toward the atmosphere.

[0007] Summary of the Invention

[0008] It is therefore an object of the invention to create a rotary leadthrough for a robot arm, in particular for a fourth axle of a Delta robot, which is constructed simply and is less vulnerable to soiling and which makes good cleaning possible.

[0009] This object is attained by a rotary leadthrough having the characteristics of claim 1.

[0010] The rotary leadthrough of the invention has a housing and a shaft, located in an axial leadthrough of the housing and supported rotatably in this housing, for connection to the robot arm. The housing has at least two openings for cleaning the axial leadthrough. The shaft, at least in a portion of its length, has a diameter which is less than the diameter of the axial leadthrough in that region, so that there is a void, in particular an annular gap that is open in at least one direction, between the shaft and the axial leadthrough.

[0011] The rotary leadthrough can therefore be cleaned easily and without tedious disassembly, by means of a fluid medium, such as water or compressed air. Furthermore, because of its construction, the rotary leadthrough is less vulnerable to soiling. The rotary leadthrough requires relatively few individual parts, making it

economical to manufacture and easy to assemble. A further advantage is that the rotary leadthrough can be put together and also secured to the robot without auxiliary tools.

[0012] A further advantage is that the shaft can be made relatively slender; that the housing is hollow; and that these parts can be made of lightweight materials. This optimizes the moment of mass inertia of the fourth axle or of the robot arm. This effect is reinforced by the fact that the mass of the shaft is concentrated about the central axis of rotation, and not spaced apart from it as in the prior art.

[0013] Further advantageous embodiments are defined by the dependent claims.

[0014] Brief Description of the Drawings

[0015] The subject of the invention is described below in terms of a preferred exemplary embodiment, which is shown in the accompanying drawings. Shown are:

[0016] Fig. 1, a perspective view of a Delta robot;

[0017] Fig. 2, a perspective view of a rotary leadthrough of the invention, secured to a carrier plate;

[0018] Fig. 3, a perspective view of a shaft of the rotary leadthrough of Fig. 2;

[0019] Fig. 4, a view of the rotary leadthrough with the carrier plate of Fig. 2 from below;

[0020] Fig. 5, a first longitudinal section through the rotary leadthrough with the carrier plate of Fig. 2;

[0021] Fig. 6, a second longitudinal section through the rotary leadthrough with the carrier plate of Fig. 2; and

[0022] Fig. 7, a third longitudinal section through the rotary leadthrough with the carrier plate of Fig. 2.

[0023] Modes of Embodying the Invention

[0024] In Fig. 1, a Delta robot is shown. Except for the rotary leadthrough D described hereinafter, it is equivalent to the known Delta robots and will therefore be described only briefly below.

[0025] It has a platelike basic element 1, on which three control arms 3 are supported so as to be pivotable or rotatable. The three control arms 3 can be moved individually by means of motors 2. The free ends of the control arms 3 are pivotably connected to a carrier element, in this case a carrier plate 5. The Delta robot also has a fourth axle 4, which is often telescoping or otherwise changeable in length. This fourth axle 4 is connected to the rotary leadthrough D via a joint 9, in particular a cardan joint or a

universal joint. A grasping element, not shown, can be secured to the rotary leadthrough D on the side of the rotary leadthrough D diametrically opposite the fourth axle 4. The type of grasping element depends on the field in which it is to be used. Examples of grasping elements are suction cups or clamping means. By means of the three control arms 3, the carrier plate 5 and thus the grasping element can be moved in three-dimensional space. The fourth axle 4 transmits a torque to the grasping element, so that the grasping element can furthermore be rotated purposefully about an axis.

[0026] In Fig. 2, a rotary leadthrough D according to the invention is shown, secured to the carrier plate 5. This view is on a larger scale; the size of the rotary leadthrough can be selected to suit the size of the robot and the field of use, without altering the concept of the invention.

[0027] The rotary leadthrough D has a housing 6 with an axial leadthrough 60. According to the invention, at least one opening, and here precisely two openings 61, 62 are present, which create a connection from the outside to the radial leadthrough 60 and are preferably located in the radial direction to the axial leadthrough 60.

[0028] The housing 6 has a securing ring 64, which is received in an opening in the carrier plate 5. The outer diameter of the securing ring 64 is preferably equivalent to the inner diameter of the opening in the carrier plate 5.

[0029] The housing 6 can be secured to the carrier plate 5 by means of clamps 10. Alternatively or in addition, connections by means of screws 11 are also possible, as

can be seen in Figs. 5 and 7. For receiving the screws 11 and for securing the clamps 10, the housing 6 has a securing flange 63 (Figs. 5 and 7), which protrudes past the substantially cylindrical basic body of the housing 6. Securing by means of clamps 10 has the advantage that the rotary leadthrough D can be removed in a simple way, and without auxiliary tools.

[0030] The basic body of the housing 6 may also take some other form. The form depends essentially on the field of use. Preferably, the housing 6 is made from plastic, so that it has a relatively low weight and assures good sliding behavior of the shaft in the housing.

[0031] A shaft 7 is rotatably supported in the housing 6 and is located in and penetrates the axial leadthrough 60. This shaft serves on the one hand to provide connection to the fourth axle 4 and on the other to provide connection to the grasping element. As can be seen from Fig. 2, it protrudes out of the duct 60 with a sliding block 76 and a connection journal 74 on the side toward the carrier plate 5 and also protrudes past the carrier plate 5. Via the sliding block 76, a groove of the universal joint 9 can be displaced, causing the connection journal 74 to protrude into the universal joint 9. The fixation of this connection is done by means of a bolt or pin, which is past through a bore in the universal joint 9 and through a bore 75, aligned with it, of the connection journal 74. Preferably, an anchor-shaped fixation means, not shown here, is used, which has a resilient curved element and a pin located on the curved element. The curved element can be fitted resiliently over the cylindrical body of the universal joint, whereupon the pin penetrates the bores.

[0032] The shaft 7 is shown by itself in Fig. 3. It is preferably made from a lightweight material, such as an aluminum alloy. It has an axle 70, which on one end merges with a cylindrical head 72 that has an adjoining journal 74 and on the other end with a star-shaped securing element 71. As a result, as can be seen best from Figs. 5 through 7, the shaft, over at least a portion of its length, namely the length of its axle 70, has an outer diameter that is smaller than the inner diameter of the axial leadthrough 60. This creates a void, embodied as an annular gap R (see Figs. 5 through 7), into which the aforementioned radial leadthrough 61, 62 protrudes.

[0033] The cylindrical head 72 of the shaft 7 has an encompassing annular groove 73 below the sliding block 76. By means of this annular groove 73, the shaft 7 can be axially supported rotatably in the housing 6. For that purpose, in its securing ring 64, the housing 6 has at least one and in this case two diametrically opposed circular-segment-shaped grooves 65. The cylindrical head 72, in the assembled state, is introduced into an opening in the securing ring 64, in which it is preferably received without play, and its outward-oriented surface is also aligned with the surface of the securing ring 64. In this state, the circular-segment-shaped grooves 65 and the annular groove 73 are in the same plane with one another. The axial position of the shaft 7 can now be fixed by thrusting segmental disks 66, preferably also made of plastic, into the circular-segment-shaped grooves 65 until they engage the annular groove 73. This can be seen best in Figs. 5 through 7. In the installed state of the housing 6 in the carrier plate 5, the segmental disks 66 rest on the side walls of the opening in the carrier plate 5 and are thus secured by it.

[0034] An intermediate member 8, which is joined to the star body 71 of the shaft 7, is also visible in these drawings. The shape of the intermediate member depends on the type of grasping element used. Preferably, however, it also has an axial through opening 80, so that the annular gap R has a connection to the outside in this direction. This can be best seen in Fig. 4. The star body 71 has the advantage that, while it makes sufficient stability and simple securing possible, nevertheless it reduces the inside cross section as little as possible.

[0035] The aforementioned radial openings now enable simple cleaning of the rotary leadthrough D, and in particular of the annular gap R, by means of a fluid medium, such as water, a cleaning solution, or compressed air. A first one of the openings 61 is a suction extraction opening, and a second opening 62 is an inflation opening. Preferably, the suction extraction opening 61 has a larger diameter than the inflation opening 62. Preferably, the two openings 61, 62 are also disposed at an angle of at least approximately 90° to one another. They may be located at the same height or at different heights.

[0036] The rotary leadthrough of the invention finds its preferred field of use, as described above, upon the leadthrough of a fourth axle of a Delta robot or similar robot. However, its use with robot arms of robots of other designs is also possible and is also part of the concept of the invention.

List of Reference Numerals

- D Rotary leadthrough
- R Annular gap
- 1 Basic element
- 2 Motor
- 3 Control arm
- 4 Fourth axle
- 5 Carrier plate
- 6 Housing
- 60 Axial leadthrough
- 61 First radial opening
- 62 Second radial opening
- 63 Securing flange
- 64 Securing ring
- 65 Circular-segment-shaped groove
- 66 Segmental disk
- 7 Shaft
- 70 Axle
- 71 Securing element (star body)
- 72 Cylindrical head
- 73 Annular groove
- 74 Connection journal

- 75 Bore
- 76 Sliding block
- 8 Intermediate member
- 80 Through opening
- 9 Universal joint
- 10 Clamp
- 11 Screw